Nuclear INFORMATION

Greater St. Louis Citizens' COMMITTEE FOR NUCLEAR INFORMATION

ST. LOUIS, MISSOURI APRIL, 1959

NEW RADIATION STANDARDS

NEWS SERVICES carried the announcement on April 23 that the National Committee on Radiation Protection and Measurements had recommended a doubling in the maximum permissible amount of strontium 90 that can accumulate in the human body in the population at large. Also reported was a recommended increase of 25 percent in the maximum permissible concentrations (MPC) of the radioactive material in foods and milk. The reports stemmed from a recent summary of the new handbook of recommendations to be issued soon by the National Committee.

This news might lead to the conclusion that danger from fallout is less than is generally supposed. Actually, such an interpretation is unjustified. It does not take into account the fact that the International Commission on Radiological Protection, to which the National Committee is affiliated, has this year lowered the permissible levels for the whole population.

The new National Committee handbook does recommend a doubling of the maximum strontium 90 body level that may be tolerated under *occupational* conditions (for atomic workers) and a 25 percent rise in the allowable strontium 90 MPC of food for this group. But this handbook does not make any specific recommendations about permissible levels for the general population.

How much is "safe" for general population?

Both the national and international committees continually examine available facts about the effects of radioisotopes, and from time to time set standards for amounts of radioactive materials that may be considered relatively "safe." These groups make identical recommendations on occupational exposure, and in addition the International Commission recommends permissible levels for the population as a whole.

A different standard is needed for the population as a whole, for it includes a large proportion of children, born and unborn, who are much more sensitive than adults to radiation damage such as bone and blood cancers. Also, atomic workers are under constant medical supervision, and their exposure to radiation can be controlled.

Previously for general populations the maximum levels recommended have been 1/10th of the amount allowed for atomic workers. Now the latest handbook of the International Commission, adopted September 9, 1958 and published this year, states that the average concentration of radioactive substances " . . . in air or water, applicable to the population at large, should not exceed 1/30th of the maximum permissible concentration value for continuous occupational exposure . . ."*

(*The Recommendations of the International Commission on Radiological Protection*, Pergamon Press, London, 1959).

In the past the recommendations of the International Commission have been followed by U.S. health agencies. Applying the new international recommendations to the new standards announced by the National Committee results in the following changes:

	Strontium 90 MPC of milk (in micromicrocuries per liter)		Strontium 90 Permissible Body Burden (in micromicrocuries per person)	
	Old	New	Old	New
Atomic Workers	800	1000	1,000,000	2,000,000
General Population	80	33	100,000	67,000

This table shows that although the permissible levels have just been *raised for atomic workers*, the new recommended reduction of 1/30th for the general population would result in the *lowering of population levels:* the milk MPC would be 41% of its former value; the allowed body burden would be two-thirds of its former value.

There are signs, however, that the National Committee may ignore the International Commission's new recommendations and follow the old standard, which allows the population 1/10th of the amount for atomic workers. In its recent statement the National Committee "considers that undue risks to the population will not be incurred by following current policies for a while longer . . . " (National Bureau of Standards, Release of April 23, 1959.)

This discrepancy will figure in the hearings that the joint House-Senate sub-committee on radiation is scheduled to hold from May 5 to May 8 on the problem of radioactive fallout and its effect on the nation's health. Representative Chet Holifield of California, chairman of the Committee, announced (UPI dispatch, April 25) that one of the items for inquiry would be the permissible levels of strontium 90 for the population. He said, "We will want to see whether these revisions (by the National Committee) are consistent with or contradictory to fallout standards issued by the International Committee . . . "

The hearings will also inquire whether there is a basis for considering *any* amount of radiation "safe." The entire concept of a permissible concentration is based on the idea that a certain amount of radiation may be tolerated without harm, but this theory has been questioned. G.C.

*The 1/30th fraction applies to somatic effects such as those caused by strontium 90; for genetic effects the recommended fraction is 1/100th.

Radiation Hazard - A Problem i

ON MARCH 26, 1959, Leroy E. Burney, Surgeon General of the U.S. Public Health Service, made public a report entitled "The Control of Radiation Hazards in the United States." This report was prepared by the Public Health Service's National Advisory Committee on Radiation (NACR), a group of experts outside the federal government. Dr. Russell H. Morgan, Professor of Radiology at the Johns Hopkins University, heads the group. The Public Health Service is presently reviewing the material and will later make its recommendations on the subject to the Secretary of Health, Education and Welfare, Arthur S. Flemming. Following is a summary of the committee's report.

Why Radiation Is a Public Health Problem

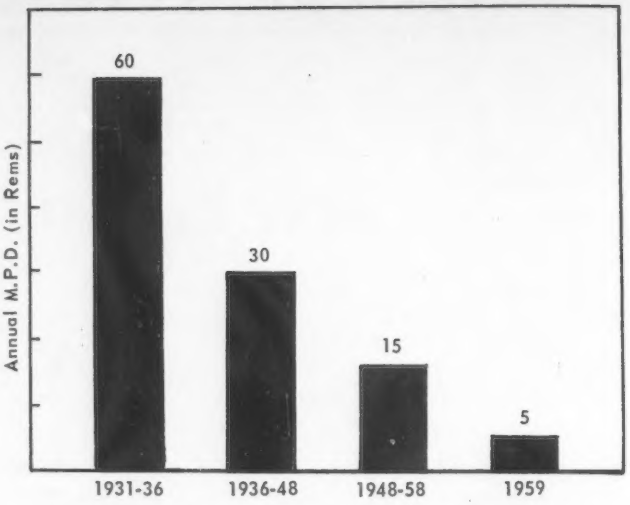
During recent years a number of authoritative scientific bodies have reported extensively on the influence of radiation on plant and animal life. The evidence presented has made it clear that serious health problems may be created by undue radiation exposure, and that every practical means should be adopted to limit such exposure both to individuals and to the population at large.

The principal sources of radiation that have been created or developed by man include X-ray machines, high-energy particle accelerators, nuclear reactors and their radioisotopic by-products, such as the radioiodine and cobalt used to treat certain forms of cancer, and a number of concentrated forms of naturally occurring radioactive materials, such as uranium, and the fallout of nuclear weapons. Among these sources only nuclear reactors and their fuels, radioactive by-products, and radioactive wastes have been placed under substantial regulation from the standpoint of their influence on health and safety. Yet most of the radiation received by the population today comes from X-ray machines employed by the health professions (medicine, dentistry, and related fields). A concerted effort is now being made by these professions to reduce, as far as possible, the exposure of individuals undergoing radiation diagnosis and treatment.

The lack of a comprehensive program through which the health hazards of *all* sources of ionizing radiation may be brought under supervision is an important weakness in the nation's efforts to control radiation safety. Comprehensive regulation is particularly essential in view of the increasing use of radiation in many phases of human activity.

Since the discovery of X-rays in 1895, the X-radiation exposure of the population has been increasing, and is now almost ten times that in 1925. The radiation from atomic sources is also likely to increase if the anticipated expansion in nuclear power development proceeds as is expected. Medical use of radioisotopes in 1958 was 20 times that in 1952. Fallout is an increasing hazard. Besides these rapid changes, another factor urgently emphasizes the nation's need for an over-all program governing the public health aspects of radiation. This is the steady downward revision in the maximum permissible level of radiation over the past 30 years. In other words, what the authorities considered a "safe" dose a few years ago, they now consider a dangerous one (see figure).

The two most important elements of an over-all



How the maximal permissible dose has fallen: Recommended permissible doses for workers exposed to ionizing radiations.

radiation protection program are the formulation of sound radiation protection standards, and the enforcement of public health regulations based on these standard. There are many gaps that exist in our understanding of the possible dangers of radiation. Since programs of control depend upon well-defined standards, it would seem that research aimed at the development of standards should be more strongly emphasized than at present.

To date, much of the responsibility for evaluation of the data on radiation protection has been borne by the National Committee on Radiation Protection and Measurments (NCRP), a quasi-official group of scientists supported by the Department of Commerce.

Federal Regulation of Radiation Protection

The federal government, by virtue of the Atomic Energy Act of 1954, occupies a dominant position in the field of nuclear energy. The AEC exercises a profound influence over the development of atomic energy in industry, medicine and other areas through its control of atomic fuels, production facilities, by-products, classified data and patents. In addition to this responsibility for the *development* of atomic energy, the AEC has been given the authority to *regulate* its operation in such a way that the safety of the public, collectively and individually, is maintained. But the extent of the problems created by the developments in atomic energy go far beyond the atomic energy production facilities. In addition, to the problems of fallout discussed in previous issues of *Nuclear Information*, and those of diagnosis and therapeutic X-ray, a whole set of problems is posed by the increasing and widespread use of radioactive isotopes. Furthermore, the disposal of unwanted nuclear wastes of the magnitude which may be contemplated when atomic industry is fully developed presents problems in terms of world population exposure that may require many years to solve.

This dual role of a single governmental agency in the promotion and development of atomic energy on one hand and the regulation of radiation safety on the other

in Public Health

is an interesting one, and poses the fundamental question whether one agency should be the judge of a hazard produced by its own operations. Already the AEC has been criticized for seemingly (on occasion) subordinating radiation safety to other considerations. Whether or not these criticisms have been justified, it is obvious that the dual responsibility of the AEC has been the cause of considerable misunderstanding, which may be expected to increase in the future.

State vs. Federal Regulation

The propriety of having the AEC perform regulatory functions in radiation safety was questioned by those who feel that such responsibility should be the function of state and local agencies. Numerous objections relate to purely state and local control, however. Among these are the fact that radiation hazards do not respect geographical boundaries, and so wider control may be needed. Also, the existence of numerous differing codes of standards might actually impede the development of atomic technology to the point of jeopardizing the national interest. Finally, the high level of competence of scientists associated directly or indirectly with the AEC and their ability to provide technical know-how for the execution of sound programs is substantial.

But not all arguments are on the federal side. Many state and local agencies, most notably in New York and Minnesota, are already intensely concerned with safety programs, and experience suggests that where regulatory controls are needed these are best exercised where the responsible authority is not too far from the groups being protected. State and local governments have repeatedly proved their competence in important areas of human activities, as for example the field of sanitation.

The NACR believes that many of the regulatory enforcement functions of a radiation control program can be discharged effectively by state and local agencies. The AEC should continue to pursue intensive control programs in its own installations and those of its contractors and licensees, but it should not continue to have primary authority over public health aspects of atomic energy. The same agency, according to the NACR, should not both promote and regulate. The NACR believes that the regulatory authority should be placed in the hands of an independent agency with a special interest in public health, i.e., the United States Public Health Service. M.M.P.

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STRONTIUM-90 In The Atmosphere and On The Earth

HOW much strontium 90 will accumulate in the world's soil as a result of the testing of nuclear weapons or their use in warfare? Accurate prediction of the eventual contamination requires information on three points: (1) how much Sr-90 is produced per kiloton of fission energy released; (2) how the fission debris is distributed at different altitudes and how long it stays in the atmosphere; (3) how Sr-90 is carried to the earth.

The first question can be answered in laboratory studies: about 100 curies is released per kiloton of fission energy. (A curie is an amount of Sr-90 that would give off 37 billion beta rays per second; it would weigh about 0.008 gram.)

The answer to the second question depends on the size of the bomb and the place where it is exploded. For small bombs on land the major part of the fallout is of the local or immediate variety. A smaller amount reaches the lower layer of the atmosphere, called the troposphere, where rain, snow, and mist collect it and bring it to earth. This is the tropospheric or intermediate fallout. At a height varying from about 30,000 feet at northern latitudes to about 55,000 feet at the equator, the tropopause marks the separation between the troposphere and the stratosphere. A one-megaton explosion has been known to drive its characteristic cloud to 77,000 feet, and thus put much of its debris directly into the stratosphere, where it stays for some time. This is the stratospheric or delayed fallout. The present estimate of the total load of Sr-90 in the stratosphere is over 4 million curies.

Rain brings Sr-90 down to earth

The third factor, how Sr-90 returns to earth, has been quite definitely established. The small fallout particles collect on water droplets and are brought to earth by rain and snow. At a given latitude the Sr-90 soil level is proportional to the total amount of precipitation. In Autofagasta, Chile, where it has rained perhaps once in the atomic age, the soil level is 1/100 of that in nearby high rainfall areas of South America. This low soil contamination is also found in dry parts of southern California.

The half-life of Sr-90 is 28 years.(Half of its radioactivity dies away in 28 years.) Knowing this plus how long it remains in the atmosphere, one can make a fairly accurate calculation of the final values in the soil. Dr. Willard Libby, the chief AEC spokesman on these matters, made the original official estimates by assuming that Sr-90 is uniformly distributed over the globe and remains in the stratosphere for ten years. He recognized that the latter figure was rough, and that the time might be as short as five years or as long as fifteen.

Actual rate of fallout beats the estimates

Evidence from the past five years shows two features which seem to contradict Libby's assumptions:

(1) There is a greater deposit of Sr-90 in the middle latitudes, the amounts at New York being seven

(Continued on back page)

Strontium-90 in the Atmosphere — *Continued from Page 3.*

times those at the equator. This is shown in the figure.

(2) There has been a sharp increase in the soil levels each spring for these five years, indicating that the time that Sr-90 remains aloft is shorter than was estimated.

Libby has attempted to explain this non-uniformity as resulting from tropospheric fallout due to tests of bombs less than one megaton in size conducted in Nevada in the spring of each year. This idea can be tested by measuring the age of the fission products in a sample of rainwater. In doing this, one looks for another form of radioactive strontium, Sr-89, whose half-life is only 60 days. Since Sr-89 thus dies away much faster than does Sr-90, the ratio of Sr-89 to Sr-90 provides a sensitive index of the age of the fission products. It has been established in this way that tropospheric fallout all comes down in less than a month, and that only about 10 per cent of all fallout remote from test sites is of this origin. So this source cannot explain the excessive deposition in the middle latitudes of the Northern Hemisphere.

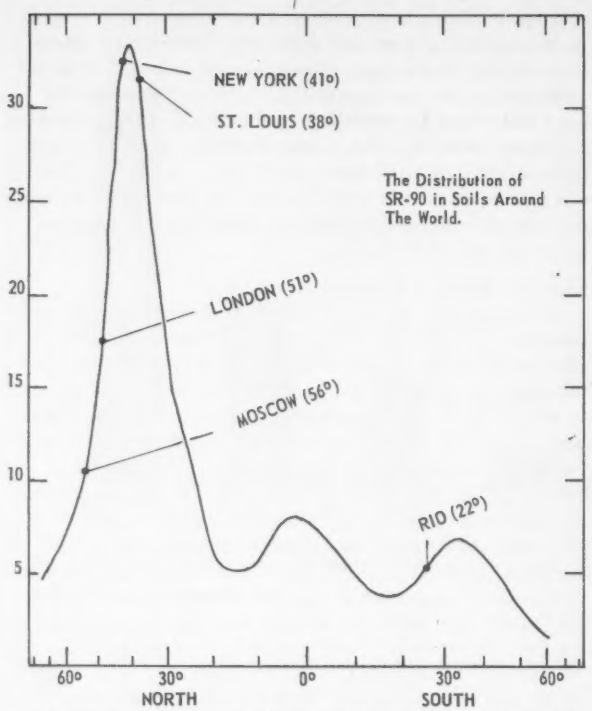
Current theories of fallout distribution

Some theories about the way air currents move have been suggested in attempts to explain the pattern of fallout. Lester Machta, Chief of Special Projects Section of the U.S. Weather Bureau, along with N.G. Stewart, a British fallout expert, has a theory of atmospheric circulation in which poleward-moving equatorial air currents carry away the debris injected into the stratosphere at the equator. These currents move north and sink into the troposphere in the temperate and polar regions. Moreover, the tropopause may abruptly change height in the northern latitudes, or it may rupture and thus allow interchange of tropospheric and stratospheric air. The increased spring deposition is explained by the sinking of the cold air mass which forms over the poles in winter. Such sinking masses of stratospheric air would bring down Sr-90 with them.

Recently E. A. Martell, of the Air Force Cambridge Research Center, has proposed a different explanation in an article soon to be published in *Science*. He suggests that the stratospheric residence time for high latitude tests is much shorter than had been suspected, and that there is little horizontal mixing or spreading. He explains both the spring rise and the concentration of fallout in the middle latitudes on the basis of the particular latitude and season of the year in which the Russian tests are conducted.

Martell points out that Machta's theory would work equally well for the northern or southern hemisphere. But the facts (see figure) show that the fallout peak is found in the northern hemisphere only.

Determination of the Sr-89/Sr-90 ratio shows that the fission debris in the spring is new, rather than a mixture of new and old material, as would be expected if the Machta-Stewart theory were correct. Actually the Sr-89/Sr-90 ratio in U.S. rains was 22 in March 1956, dropped to 9.7 in April and remained low through June.



The vertical axis represents Sr-90 concentration in microcuries per square mile. This graph is based on data available in December, 1957.

(A rise in July was attributed to the Pacific "Redwing" tests in May 1956.) The March-June figures thus agree well with the idea that the Russian tests of the preceding autumn were a prominent source. Russian debris falls on St. Louis — and Moscow.

High-yield American and British tests are conducted not far from the equator, Russian tests much further north, at 52° N. For the former, Martell suggests, the Libby theory might be correct. Debris from near-equatorial tests might well be mixed globally, have a residence time of 5 to 10 years, and be distributed by rainfall. But the Russian debris, injected at middle latitudes in the fall and winter, would not be mixed horizontally, and the maximum deposition rate would occur during the next two to four months.

This view is supported by the fact that wind velocities at high altitudes (12 miles) are very much greater at the equator than in the middle latitudes. The American and British debris, therefore, would be thoroughly mixed and widely distributed, whereas the Russian debris would be largely confined to the latitude of St. Louis, New York, London and Moscow. Although the American and British debris is greater in total amount, the Russian debris probably accounts for 75 per cent of total fallout in our area.

Experimental evidence to support this picture is thus far scanty. No matter what meteorological explanation eventually proves correct, however, it is already clear that fallout tends to concentrate in middle latitudes, and that soil radioactivity increases sharply in the spring. We can therefore agree with Martell's conclusion that "the predicted contamination consequences for high-yield middle latitude detonations must be revised upward." J.M.F.